

# Electrical Safety Organisation at CERN



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CERN specific rules  
Preventive Measures  
Accident Procedures

# *CERN Safety Codes*

*invoke CERN Safety Instructions explained  
by*

*Safety Notes*

*For electricity:*

*Code C1-->IS24-->French National Rules*

*NF C 15 100 for Low Voltage (up 1 kV  
AC), NF C 13 200 for High Voltage*

*UTE C 18-510 for Procedures*

*Decree 88-1056 for the protection of  
workers*

# *CERN Safety Codes*

*Why national rules in an international laboratory?*

*France is one of the host states*

*France is subject to European Union Directives*

*The second host state, Switzerland, follows anyway the rulings of its powerful neighbours, at least in electricity.*

# Specific CERN rules

## *CERN Code C1*

*Provides the framework for Electrical Safety at CERN*

*gives the link to all mandatory rules*

*requires adequate training levels*

*requires equipment and installation owners to pass inspections*

# Specific CERN rules

## *CERN Safety Instruction 5*

*Provides General Emergency Stop facilities  
in all areas at risk*

## *CERN Safety Instruction 23*

*Forbids use of cables that propagate  
flames, contain halogens, produce too dense  
or too acid fumes, are not resistant to  
ionising radiation*

# Specific CERN rules

## *CERN Safety Instruction 48*

*Makes certain rules of good workmanship a mandatory requirement*

## *CERN Safety Note 24*

*Recalls the procedures to be applied when dismounting cables*



**High Voltage A**  
**(H.V.A)**

AC voltage between 1 kV and 50 kV or DC voltage between 1.5 kV and 75 kV

**High Voltage B**  
**(H.V.B)**

AC voltage above 50 kV or DC voltage above 75 kV

**Extra Low Voltage (E.L.V.)**

AC voltage below 50 V and DC voltage below 120V

**Low Voltage A (L.V.A.)**

AC voltage between 50 V and 500 V or the DC voltage between 120 V and 750 V

**Low Voltage B (L.V.B.)**

AC voltage between 500 V and 1 kV or DC voltage between 750 V and 1.5 kV

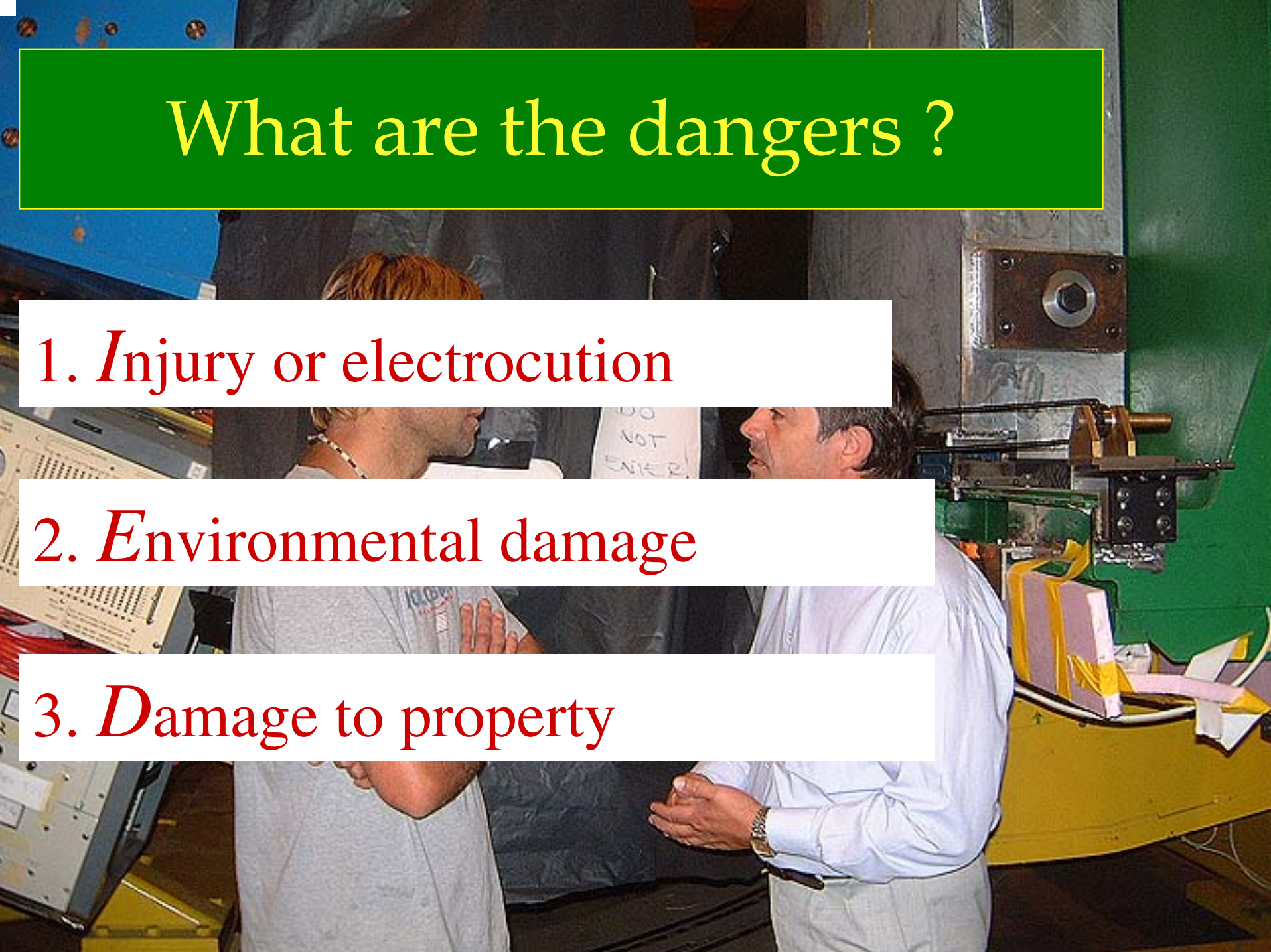


# What are the dangers ?

1. *Injury or electrocution*

2. *Environmental damage*

3. *Damage to property*



# *Electrical Safety in Physics 1*

All experiments and accelerators use plenty of non-standard configurations and equipment.

No separation of services,  
radiation, EMC, non-CE equipment.  
Experiments do not have experienced operators.

**Risks: fire, explosion or smoke,  
(fatal) injury, extensive damage**

# *Electrical Safety in Physics 2*

## Origin of Electrical Risks:

Low & High Voltage DC (PM's, bias)

Low Voltage AC (crates, equipment)

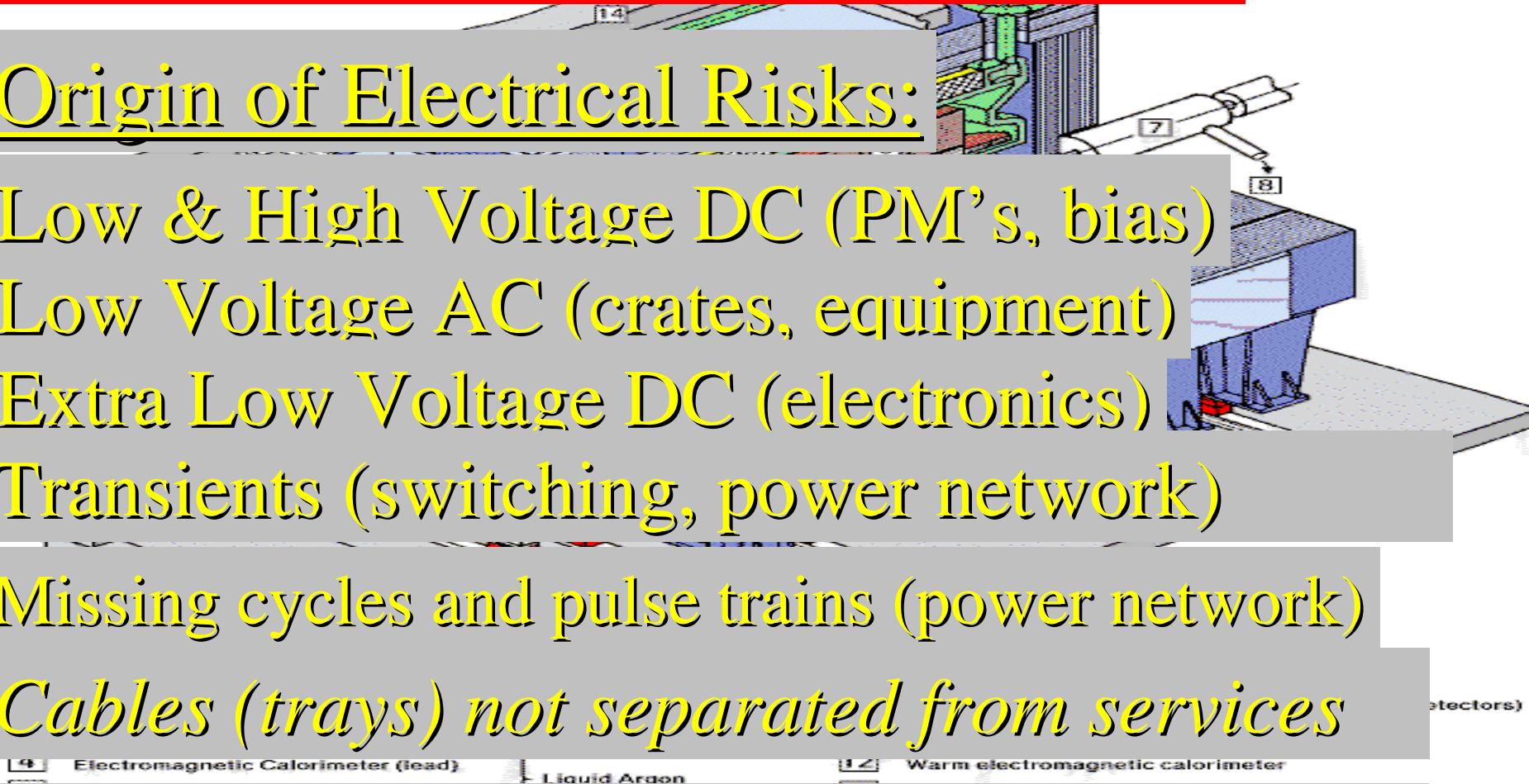
Extra Low Voltage DC (electronics)

Transients (switching, power network)

Missing cycles and pulse trains (power network)

*Cables (trays) not separated from services*

*Fields, Radiation, large short-circuit currents, superconductivity*

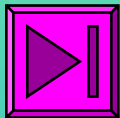


# *Electrical Risk Prevention*

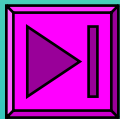
Prevention =

Legal responsibility of everyone  
operating equipment @ CERN

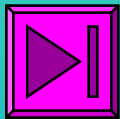
*In legal terms we require :*



*Equipment conformity*



*Installation conformity*

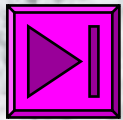


*Procedure conformity*

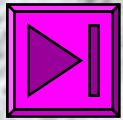


# *Electrical Risk Prevention by Conformity*

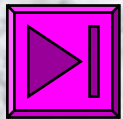
**Background:** *European Directives for low voltage and electromagnetic compatibility*



*Equipment certified “CE”*



*Declaration of conformity*



*Safety Comm. verification*

*US 117 V AC equipment: ok with add'l rules*

*400 Hz equipment: special rules for large installations*

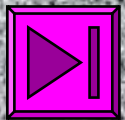
*halogenes (PVC etc.): not allowed*

# *Electrical Risk Prevention* *by Installation Check*

Background: *European Directives for low voltage and electromagnetic compatibility*



*Installation done professionally*



*Other type of installation*

*SC reception required for*  
*ALL installations @ CERN*

# Electrical risk prevention by Procedure

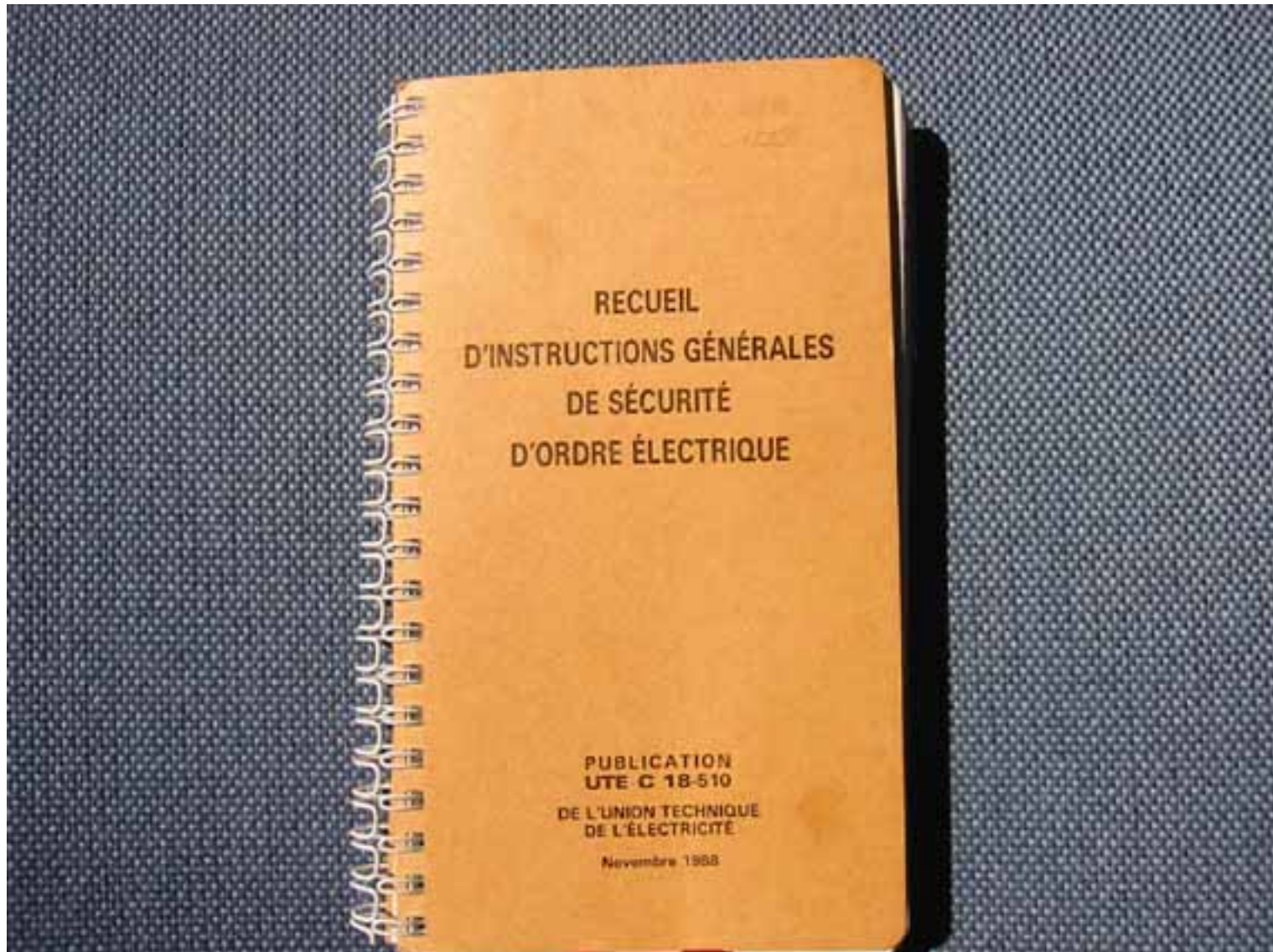
Background: *French Standard “Recueil d’instruction générales de sécurité d’ordre électrique” UTE C 18 510*

Concerns: Operation of electrical equipment, interventions, modifications

Training & examination for safe operation of electrical equipment required at CERN (“habilitation”). Experiments: no exception



# *The Procedure Bible*



# Isolation and Energy Dissipation (French: “Consignation”)

Background: *French Standard “Recueil d’instruction générales de sécurité d’ordre électrique” UTE C 18 510*

*Concerns: Putting an electrical installation into a safe state prior to interventions*

*Five steps:*

<u>Separation (isolation) of sources</u>
<u>Lockout (condamnation)</u>
<u>Identification</u>
<u>Check absence of tension</u>
<u>Earth and short</u>

# *General Electrical Safety Measures at CERN - Earth*

- a) Earthing in configuration TN-S*
- b) All magnet circuits isolated with ground fault detection*
- c) All physics detectors use a single ground system for equipotentiality. Physicists are trained to live with this restriction.*
- d) EMC is integral part of the apparatus which is also an EU-Directive*



# *General Electrical Safety Measures at CERN - hierarchy*

*e) Four-fold power network hierarchy*

*with 27 distributed backup power sources*

*f) Emergency lighting and all safety-relevant circuits on UPS*

*g) Separation of dirty and clean networks*

*h) 4 Independent supply networks*

*(400 kV Romanel, 400 kV Genissiat, 400 kV and 130 kV Verbois, 18 kV Renfile)*

# General Electrical Safety Measures at CERN - LHC+Exp.

- i) CMS: 6 x 18 kV + 20 kV EDF + Diesel  
Bipolar power supply for our biggest coil
- j) ATLAS: 66 kV 70 MVA + 18 kV + Diesels
- k) Static 150 MVAr compensator for power quality, plus old unregulated SPS compensator
- l) Functional Safety in LHC is a high priority item with close follow-up

275kVA,



750kVA, 400V



275kVA, 400V

ATLAS

MP5

SIG

18kV Secours  
20kV EDF

# *General Electrical Safety Measures at CERN - general*

- m) Differential circuit breakers on all outlets*
- n) Connector coding for dedicated networks (e.g. computer farms running on specially compensated networks supplied by UPS)*
- o) Certified software for safety relevant parameters (short circuit power at any point must match fuse settings and cut-out capability)*

# *General Electrical Safety Measures at CERN - general*

- p) Concrete reinforcement linked to TN-S*
- q) Access restrictions to premises with higher risk levels (i.e. substations)*
- r) Tight regulations on insulation materials and flame retarding*
- s) Superb interdisciplinary risk coverage (e.g. gas systems, cryogenics, ventilation)*



# *General Electrical Safety Measures at CERN - general*

- t) Mandatory Electrical Safety training for everyone handling electricity (researchers incl.)*
- u) Very good intrinsic safety level on equipment level (CE label + proof required)*
- v) Mandatory inspections for all installations*
- w) 18000 departure point alarm system connected to Fire Brigade and Technical Control Room*

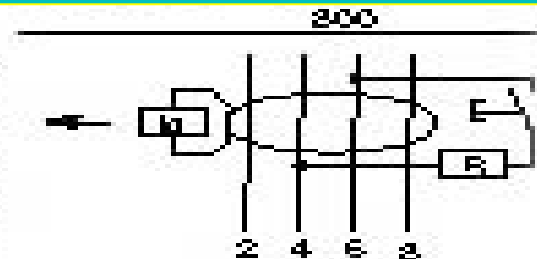
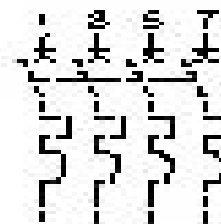
# *General Electrical Safety Measures at CERN*

- x) Concrete reinforcement linked to TN-S*
- y) Access restrictions to premises with higher risk levels (i.e. substations)*
- z) Tight regulations on insulation materials and flame retarding*
- aa) Superb interdisciplinary risk coverage  
(e.g. gas systems, cryogenics, ventilation.)*

# Differential circuit protection at CERN

It protects human beings and animals from current between circuit & earth.

CERN: FI 30 mA (outlets)  
FI 10 mA (test benches)  
No FI for safety (or old) installations  
Cut-out of neutral is mandatory



# *Safety Distances for High Voltage Equipment*



## *Safety distances and access limitations*

for High Voltage Equipment in High Energy Physics:

Connected and protected against direct contact: no limit

Unprotected: distance = 50cm + voltage dependent safety distance

Intervention: Only after cut-out, discharge, lock-out, check

# AUG

## General Emergency Power Cut

Cuts all beams and energy sources;  
residual energies are disposed of safely

Safety equipment must be declared and  
marked as such (colour=orange). It remains  
**under power** (lights, elevators, access/alarm sys., network, ventilation, pumps)

*Do not be afraid of a power cut. Systems  
are supposed to be conceived such that they  
enter a fail-safe condition and are able to  
restart and synchronise automatically.*



# *What is the electrical safety inspector required to look at ?*

Fire prevention

Protection against direct contact

Protection against indirect contact

Electrical protection

Installation conditions

Emergency power cut

Equipment conformity

Procedure conformity



# *What does the experimenter have to do ?*

Do conceptual design together with experts

Respect the Codes and CEM standards

Be aware that important electrical apparatus can be dangerous

Use 117 VAC with care

Have installation well documented which facilitates the check (“reception”)

Have your people trained for the level required

Conduct safely your experiment





*In case of an electrical accident*

*Cut out/lock out and rescue*

*Enquiry by: Electrical inspection enquiry or “fact finding” for more severe accidents. The report lists facts: circumstances, injuries, victims and witnesses, causes and immediate measures.*

*Results are made available to hierarchy or an eventual Accident Board. They decide on actions or sanctions. Court procedures come into play upon a certain severity or when one of the persons involved cannot make his case otherwise.*

# Serious electrical accidents at CERN since 1957, and conclusion

- 1970 SIG fall from HT pylon F  
(No CERN responsibility)
- 12.08.75 ets Onet electrocution F  
(Bad supervision of cleaning contractor)
- 08.11.76 CERN electric shock (injured)  
(Full CERN responsibility)
- 13.01.81 ets Spie electric shock (injured)  
(responsibility of CERN employee)

Our safety record in electricity became very good

CERN is below average accident rate of host states

CERN continues its substantial efforts  
in prevention and training